AD-A126 251 FUNCTIONAL EVALUATION OF THE WASHINGTON-AREA TELERADIOLOGY DEMONSTRATION..(U) LITTLE (ARTHUR D) INC CAMBRIDGE MA 08 OCT 82 ADL-86296-VOL-1 1/1

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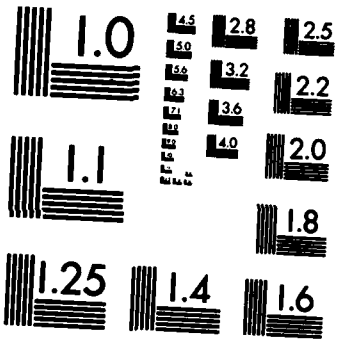

0209-2-TEL-1-Y-FINAL-VOL.I

FUNCTIONAL EVALUATION OF THE WASHINGTON-AREA TELERADIOLOGY DEMONSTRATION PROJECT

VOLUME I
SUMMARY OF FINDINGS

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October 8, 1982

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: 0209-2-TEL-1-FINAL-VOL. I	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): Post Implementation (Period Y) Evaluation Plan for the Washington Area Teleradiology Demonstration Project	5. TYPE OF REPORT & PERIOD COVERED: Final Report 2/17/82-10/8/82
	6. PERFORMING ORG. REPORT NUMBER: 86296
7. AUTHOR(s): Arthur D. Little, Inc.	8. CONTRACT OR GRANT NUMBER(s): MDA-903-81-C-0209
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Arthur D. Little, Inc. Acorn Park Cambridge, MA 02140	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 0209-2-TEL-1
11. CONTROLLING OFFICE NAME AND ADDRESS: TRIMIS Program Office 6917 Arlington Road Bethesda, Maryland 20014	12. REPORT DATE: October 8, 1982
	13. NUMBER OF PAGES: 10
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report)
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for Public Release, Distribution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Teleradiology, Automation

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A summary of findings regarding the potential functional effectiveness of Teleradiology in small remote clinics.

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SUMMARY OF FINDINGS

A. INTRODUCTION

Teleradiology is an automated system whereby an electronic representation of an X-ray image is transmitted via telephone wires from one location to another. The TRIMIS Program Office (Department of Defense) and the Bureau of Radiological Health (Public Health Service) have conducted a six-month field trial of a Teleradiology system. The system, which was designed by the MITRE Corporation, was studied to evaluate its performance in a routine medical practice setting.

In the fall of 1980, four small clinics in the Washington, D.C. area were chosen as transmitter sites for the trial and a large radiology department was selected as the central receiver site. Training for site personnel began in the fall of 1981. The system was installed in January of 1982, becoming fully operational in late March, and remaining so through June. Baseline (pre-implementation) data collection for the functional evaluation of the Teleradiology system was conducted by the Bureau of Radiological Health for two weeks in February of 1981 and by Arthur D. Little, Inc. for two weeks in September of that year. Post-implementation data were collected by Arthur D. Little, Inc. for two weeks in June of 1982.

The Teleradiology system was experimental and, hence, was not used as a replacement for normal film interpretation of X-ray exams during the field trial. The "manual" systems used by each of the transmitter clinics continued to be used in parallel with Teleradiology. Because of the parallel use of Teleradiology and "manual" methods for obtaining interpretations, many of the data collected for the functional evaluation were designed to estimate the system's potential impact, rather than to directly measure its impact in the experimental setting.

Data were collected concerning:

- the potential impact of the system on patient care;
- the acceptability of the system to users;

- the potential feasibility of using the system in routine practice settings; and
- the potential impact of the system on costs of transmitter site X-ray services.

B. THE STUDY SETTING

The central receiver site for the Teleradiology field trial was the Radiology Department at Malcolm Grow Medical Center at Andrews Air Force Base in Maryland. During the field trial, this large radiology department continued, for the most part, to operate as it had before. The Teleradiology equipment was physically separated from the other viewing rooms in the department, and both the radiologists and the transcriptionists who used the system were hired for the project.

The four medical facilities used as transmitter sites during the field trial were:

- Bolling Air Force Base Clinic, Washington, D.C.;
- Fort Detrick Army Clinic, Frederick, Maryland;
- Patuxent Naval Air Station Hospital, Lexington Park, Maryland; and
- Central Virginia Community Health Center, New Canton, Virginia.

These clinics and their X-ray departments are quite small and are oriented primarily toward the delivery of outpatient services. The clinics vary in workload from 21,000 outpatient visits per year to 85,000. Their X-ray departments range from having one technician, one X-ray room and examining 1,400 patients per year to four technicians, two rooms and 7,000 patients per year. Each of the four sites has standard arrangements with specific medical centers for secondary and tertiary care referrals. Their distance to these medical centers varies from 10 to 90 miles. Normally, two of the four clinics send their X-ray films by courier to medical centers for interpretation; one employs a part-time radiologist to perform film interpretations;

and the fourth sends films away every other week, employing a visiting radiologist during the off-weeks.

During the field trial, the transmitter departments continued to have their films read "manually," as they had before. At each of four of the transmitter sites, the regular technicians were trained to use the Teleradiology system and did operate it. However, at three of the sites, additional temporary personnel were also hired to accommodate system use.

C. RESULTS: REAL AND POTENTIAL IMPACTS

1. Impact on Patient Care

The potential impact of Teleradiology on patient care was studied in two ways. First, turnaround time of interpretation reports was measured for all exams ordered during the two study periods (before and after the Teleradiology system was installed). And second, a study was conducted of how radiographs and X-ray interpretations were used in patient care at the transmitter facilities. All data regarding turnaround time and patient care impacts were collected using a self-administered survey form, which followed each X-ray through the various stages of the X-ray request/report cycle and was completed by clinic staff. Data were collected regarding a total of 418 patients (453 exams) before system implementation and for 618 patients (695 exams) during system operation.

a. Turnaround Time: X-Ray Request/Report Cycle

Over 90% of the X-rays at each of the four clinics and during both data collection periods were performed within two hours of being ordered. However, delays of several days often occurred between the exam's performance and its interpretation by a radiologist and between this interpretation and its review by the referring provider.

The total mean turnaround time required for "manual" film interpretation reports before system implementation was found to range from 88 hours to 108 hours at the four study sites. During system operation, mean turnaround time for "manual" film interpretation reports was somewhat longer, ranging, at the the four sites, from 121

to 233 hours. This increase in turnaround time may be associated with:

- the parallel use of the two interpretation modalities during the post-implementation data collection period; and
- miscellaneous breakdowns in the "manual" interpretation systems during the post-implementation data collection period.

The total mean turnaround time required for automated Teleradiology interpretations was even longer than that for manual services. This mean varied from 181 to 212 hours at the four sites. Delays for receipt of Teleradiology interpretations were largely attributable to the fact that the system was only used experimentally:

- the system did not initially function reliably;
- X-ray images were not always input regularly or on a daily basis;
- radiologists were only available to perform Teleradiology interpretations during morning hours five days each week;
- "manual" interpretation reports were often received prior to Teleradiology interpretations of the same exam, and, hence, were not always read promptly.

In order to project the impact of a refined Teleradiology system in routine use (a non-experimental setting), it is assumed that the system would be implemented and utilized quite differently. For example:

- a non-experimental system would probably be more reliable;
- if the system were used routinely, a protocol would probably be established for inputting films into the system regularly;
- a radiologist would probably be available on a full-time basis; and
- no parallel "manual" system would be available.

Based on these assumptions, the data collected during the post-implementation period suggest that in a non-experimental situation, turnaround time for Teleradiology interpretation reports could be much shorter than that observed during the field trial. Inputting of films

requires approximately 10 minutes per exam, and telephone line transmission takes an additional 15 to 30 minutes per exam. As soon as transmission is complete, interpretation may be performed, and either the telephone or the tele-typewriter may be used to communicate findings immediately to remote providers. We project that a 24-hour total turnaround would be possible for routine exams and that a 1-hour turnaround could be accomplished for STAT exams.

b. Impact on Patient Care

Data were collected concerning the types of X-rays performed during the two study periods at the transmitter site X-ray departments. Also, for each X-ray ordered during the study periods, referring providers were asked to answer three different questions concerning the use of interpretations in patient care. These questions concerned the relative significance of prompt receipt of a radiologist's interpretation; the role of X-ray film viewing in patient care decisions; and the role of the radiologist's report in these decisions. Little variation existed between the two data collection periods in the types of exams performed and the patterns of provider response to "patient care" questions. Hence, these data have been pooled for presentation.

The X-ray exams performed at the study sites were grouped into four categories corresponding to various clinical uses:

- Routine physical chest exams;
- Emergency exams associated with acute trauma;
- Diagnostic exams not associated with acute trauma; and
- X-rays taken "for the record" or as follow-up exams.

The case mix in the X-ray departments at each of the transmitter facilities is quite limited, as would be expected in primary care clinics. Also, the distribution of X-rays performed at the military sites is somewhat different from that at the civilian clinic, Central Virginia Community Health Center (CVCHC). During the two study periods, 23% of the X-rays performed at the military sites were associated with routine physicals (compared with 6% at CVCHC); 40% were associated with acute trauma (compared with 28% at CVCHC);

17% were other "diagnostic" exams (compared with 50% at CVCHC); and 20% were performed "for the record" or as follow-up procedures (versus 16% at CVCHC).

At the time that the exam was requested, providers were asked to categorize how significant prompt receipt of a radiologist's interpretation would be in patient care. In 73% of cases, providers indicated that prompt receipt of a radiologist's interpretation would have some effect on their opinions or decisions regarding patient care. Timely interpretation receipt was considered "very significant: essential to patient care decisions" in only 8% of cases. Rapid interpretation turnaround was felt to be most important for exams associated with trauma and other diagnostic exams and least significant for routine physicals.

After X-rays were performed at the transmitter facilities, the requesting providers viewed the films themselves in a majority of cases. Providers were most likely to review exams associated with acute trauma (77%), followed by non-emergency exams that they considered diagnostic (69%) and radiographs performed "for the record" or as follow-up procedures (62%). They seldom viewed routine physical chest exams (10%).

If and when the referring provider viewed the films that he had ordered, he was asked to categorize how he felt this viewing had affected his handling of the case. Usually (in 65% of cases) the viewing of radiographs served to "increase the clinical confidence" of providers. Sometimes -- primarily in trauma cases or for other diagnostic exams -- providers reported that the film viewing had had a major effect on handling of the case (16% and 21% of cases, respectively). It was least likely to have had a major effect for routine physicals (4% of cases).

At the time the provider reviewed the radiologist's film or Teleradiology interpretation report, he was asked what effect the specialist's report had made on patient treatment/disposition decisions. At the transmitter sites radiologists' interpretations were almost always received several days after the X-ray had been

performed and the patient treated and sent home (see above). Reports received after so long a delay would not be expected to have much effect on patient care unless their findings differed substantially from those made earlier by the referring provider. Indeed, by the time radiologists' reports were reviewed, they were felt to have had no effect no patient care for 41% of cases. Forty-three percent of radiologists' reports were felt to have "increased the clinical confidence" of the providers. It is interesting to note, however, that in each X-ray category, some radiologists' reports were reported to have had a major effect on care (6% for routine physicals; 8% for emergency exams; 10% for other diagnostic exams; and 7% for exams performed "for the record" or as follow-up procedures).

2. User Acceptance

During the post-implementation data collection period, system users were questioned regarding their opinions of the system and its utility. The response rate for each survey was over 90%.

a. Acceptance by Primary Care Providers

Overall, providers' comments were positive. Most of their enthusiasm, however, was derived from the system's potential utility rather than actual benefits realized during the field trial. Providers believed that the system could be valuable where turnaround time reduced to a few hours or to a single day. Also, at some of the sites, providers felt that 24-hour availability of interpretation services was important.

b. Acceptance by Receiving Site Radiologists

The radiologists who had participated in the field trial at Malcolm Grow Medical Center completed a written questionnaire regarding their experience with the system. The radiologists' comments were enthusiastic. They felt that the quality of images received was generally good and that image resolution was usually adequate.

c. Acceptance by Technicians

Each technician who used the system at the transmitter sites was interviewed. All felt that once the system had become reliable, it had been easy to use. This opinion was expressed both by trained radiology technicians and by the non-technician system operators. The non-technicians did require somewhat more time to become accustomed to the system -- to learn the correct positioning and focusing of films -- but soon became very adept at its operation.

Transmitter site personnel did criticize some aspects of system design, primarily complaining that the film inputting activity was tedious and time-consuming.

3. Feasibility of Routine Use

In order to determine the feasibility of using the Teleradiology system in routine medical practice settings, its potential impact on the daily routines was studied at both the transmitter sites and at the central receiver site.

Several days of work sampling were performed at each of the four transmitter sites both before and after system implementation. During both study periods, approximately fifty percent of X-ray department staff time was spent in activities unrelated to X-ray department work. (Workload is extremely uneven in these small departments, and much of this time was spent "on-call" for X-ray duty during non-busy times.) Performing and processing each X-ray and doing the paperwork and filing associated with radiographs took between 20 minutes and 40 minutes per exam; inputting Teleradiology images required an additional 10 minutes per exam. It is assumed that these figures are good estimates of the amount of time that would be required were the system in routine use. Although all but one of the transmitter sites did increase their staff between our first and second study periods, the data fail to show that these staff increases would be required to accommodate routine system operation.

Time studies performed on radiologists interpreting X-ray films were conducted before system implementation and similar studies were conducted under Teleradiology. It was determined that video viewing

is no more time consuming than film viewing, and similarly, that typing of Teleradiology interpretations requires no more time than regular report typing.

From these work sampling and time study data, one could infer that small moderately busy X-ray departments should be able to accommodate Teleradiology system operation into their daily schedules without an increase in staff. Large radiology departments who currently accommodate interpretations of X-ray films, could similarly accommodate interpretations of the Teleradiology images of the films.

4. System Costs

To determine the potential impact of Teleradiology on X-ray department costs, the estimated costs of the Teleradiology system at the four transmitter clinics were compared with the two "manual" methods for obtaining radiologists' interpretations of X-rays performed at these clinics. These two "manual" methods are (1) using a courier to transport films and (2) employing a part-time visiting radiologist. In the field trial transmitter sites, the equipment and staff necessary to perform and process X-ray exams are essentially the same regardless of which of the three systems is used. Hence attention was focused only on the incremental costs associated with the three alternatives. The cost of using the experimental Teleradiology system in the field trial sites was found to be approximately $7 per X-ray exam, compared with an estimated $2.50 per exam when a part-time visiting radiologist is employed and $0.50 when a courier system is used. These relative costs would, of course, vary in different settings.

C. SUMMARY AND CONCLUSIONS

A refined Teleradiology system would make available to remote clinics the same access to radiologists' interpretation services as is currently available to large hospital outpatient departments. The remote clinics would have routine interpretations returned to providers within a day or two and "wet readings" of films would be accessible at any time during the day. Primary responsibility for

radiological interpretation would be shifted from the primary care provider to the radiologist.

At clinics typified by the four transmitter sites involved in the field trial, it appears that Teleradiology can provide a much more rapid turnaround of radiologists' interpretation reports than can either of the standard "manual" methods for obtaining film interpretations. The system appears feasible to use in small transmitter site X-ray departments and a large central receiving site. It has been demonstrated to be acceptable to users. At the field trial sites, alternative methods for obtaining interpretations were readily available, and were less expensive than using Teleradiology.

In the vast majority of cases, providers in transmitter clinics expressed a preference for receiving expert interpretations promptly rather than relying on their own readings of films. However, the importance of X-ray examinations and the significance of prompt receipt of radiologists' interpretations was found to vary with X-ray exam type. Providers indicated that radiographic findings were most relevant to immediate care in trauma cases, less so for other diagnostic exams, followed by examinations performed "for the record" or for follow-up, and, finally, they were felt to be least immediately relevant for routine physical examinations.

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